

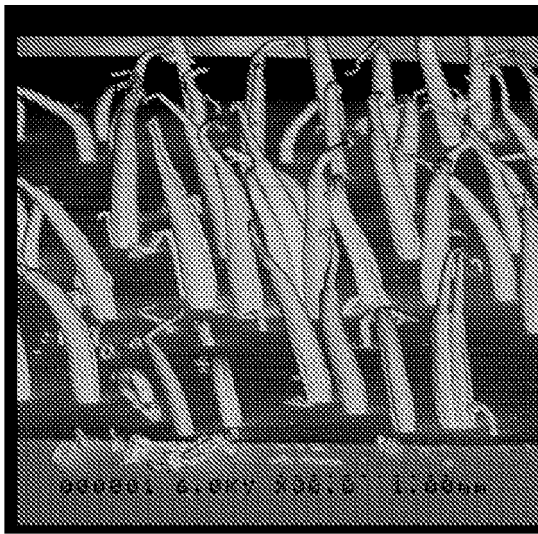


Fig. 1a

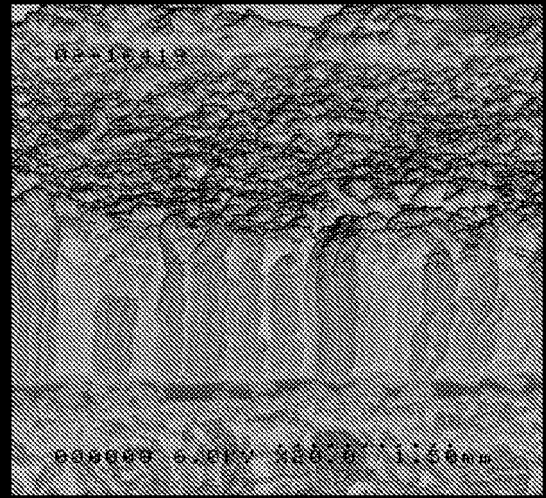


Fig. 1b

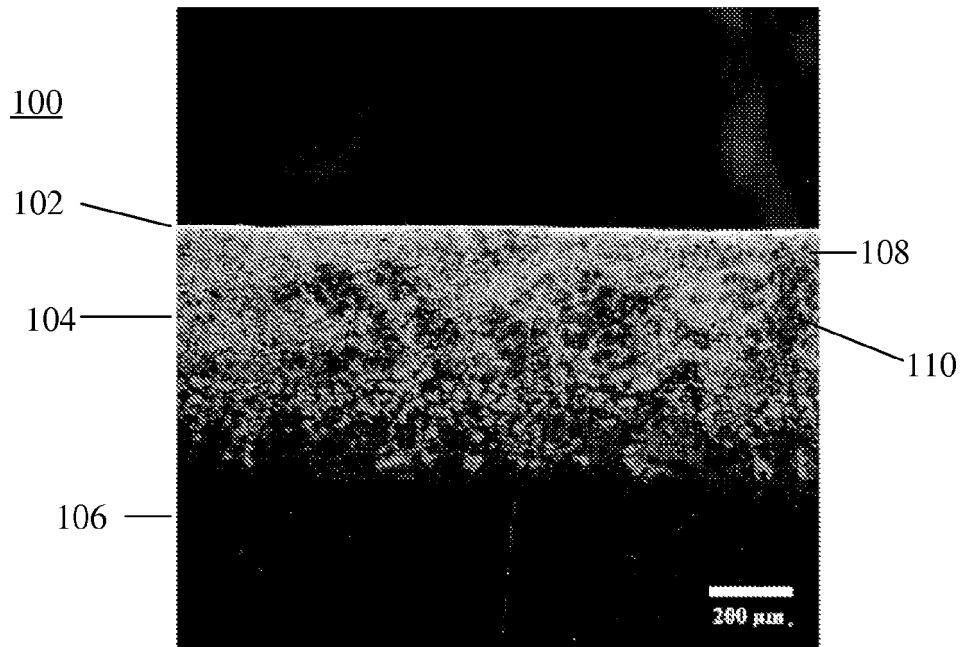


Fig. 2

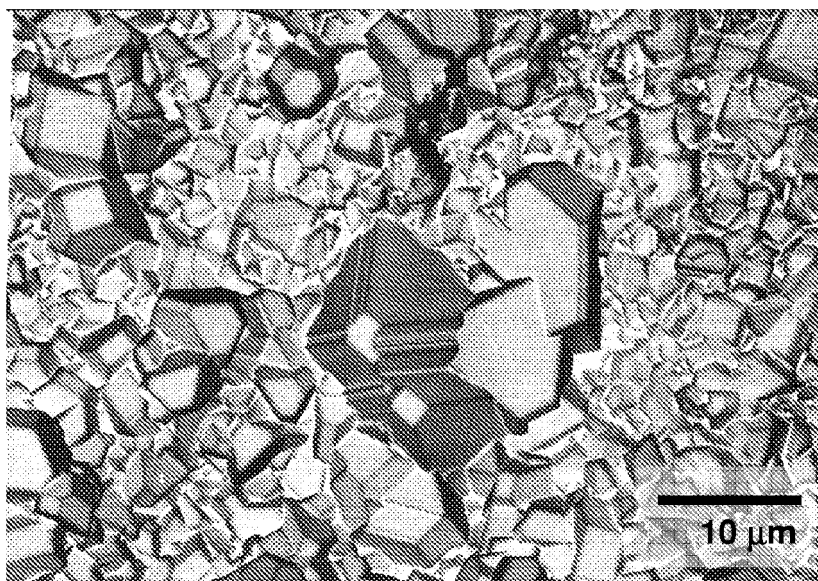


Fig. 3

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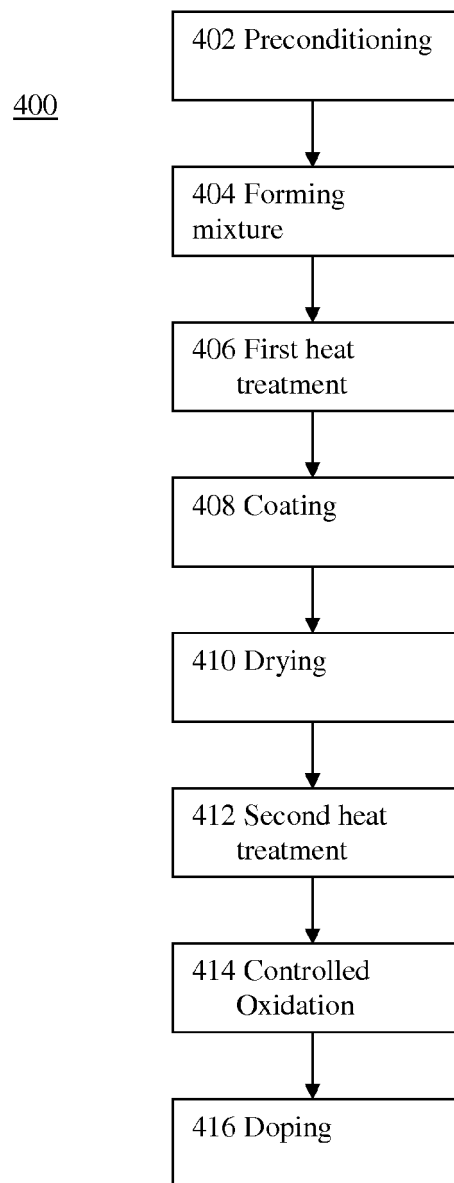


FIG. 4

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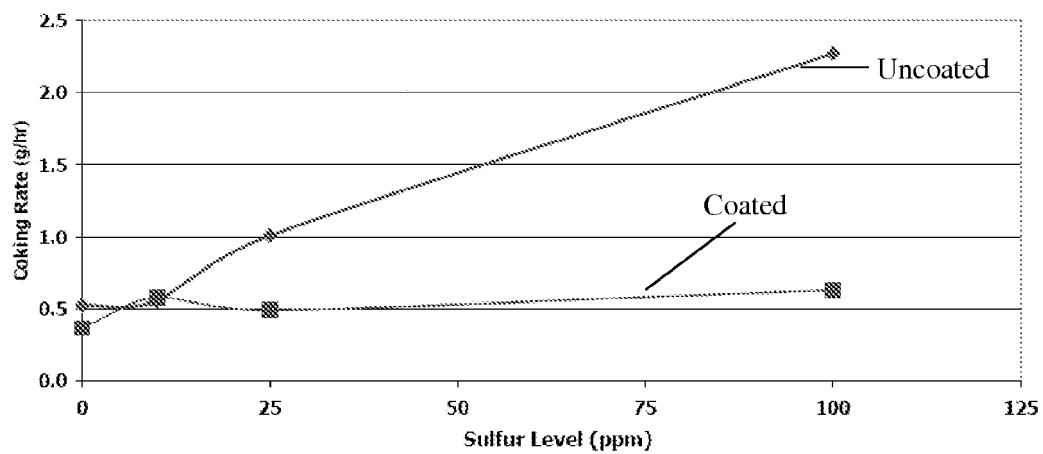


FIG. 5

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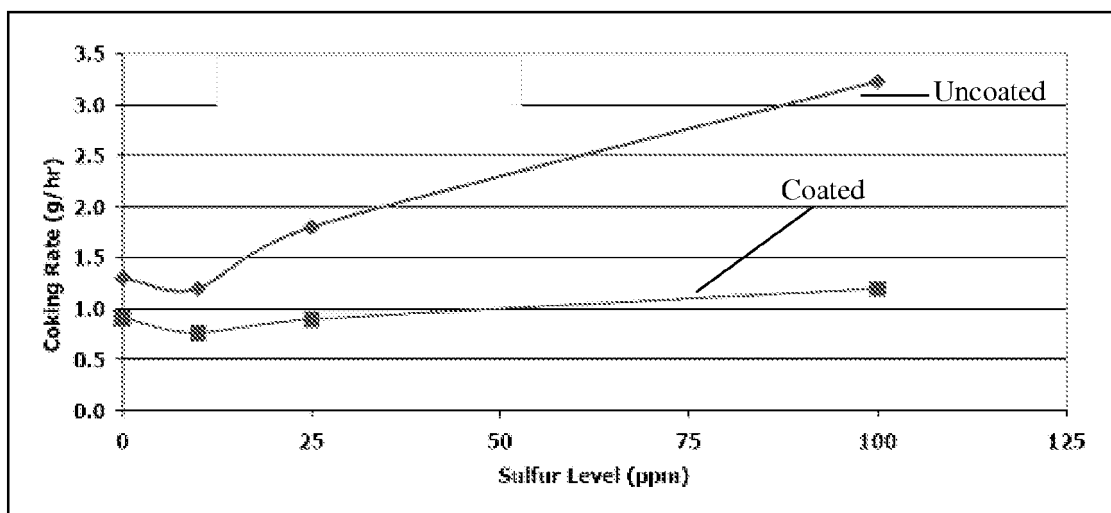


FIG. 6

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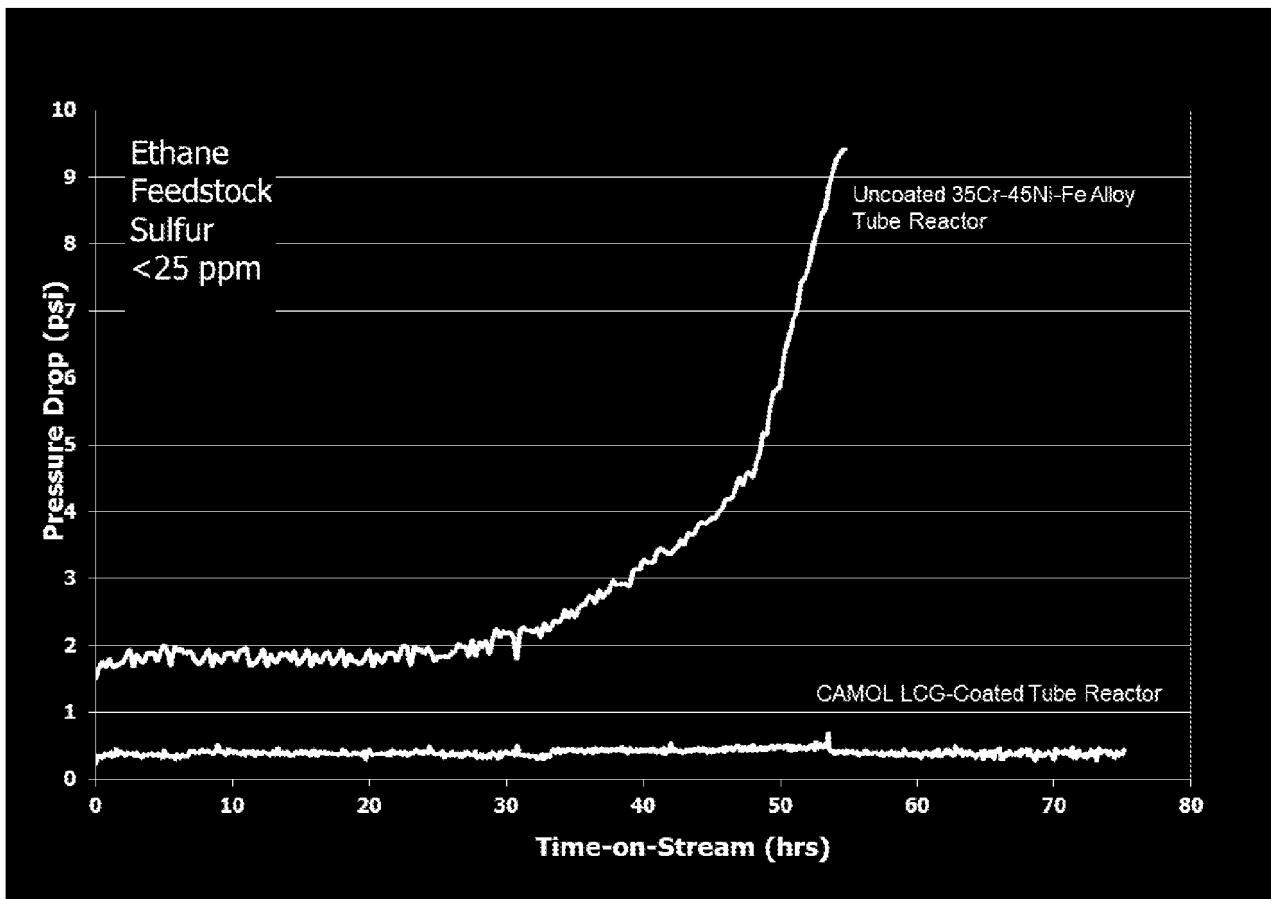


FIG. 7

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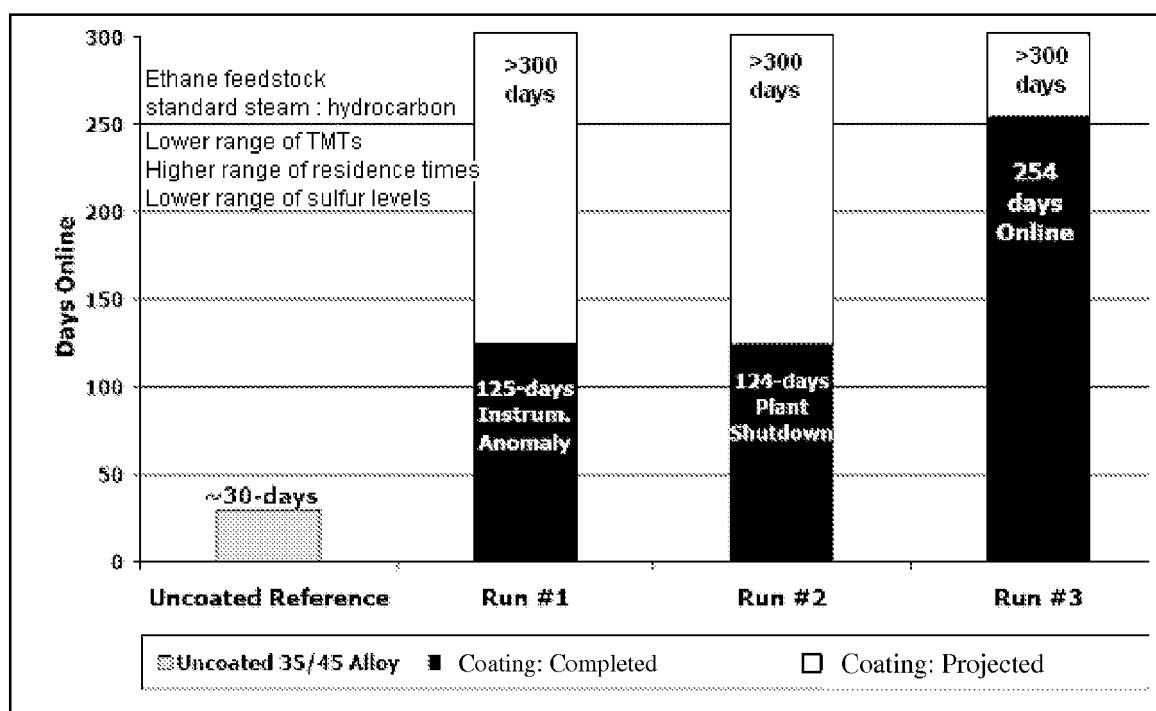


FIG. 8

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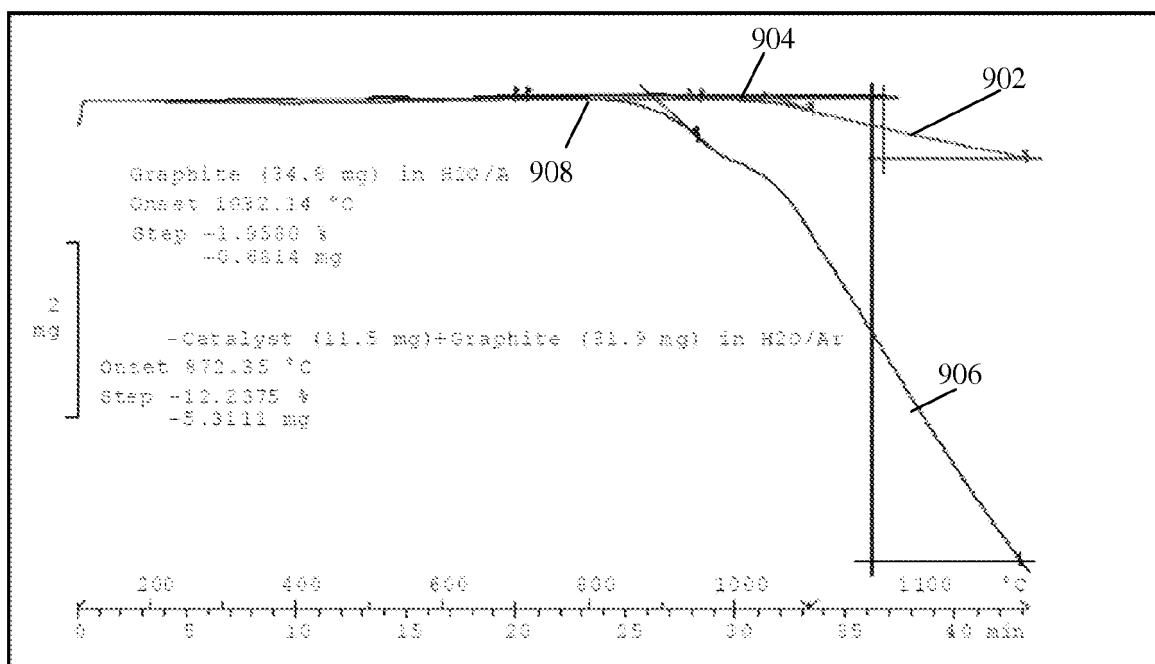


FIG. 9

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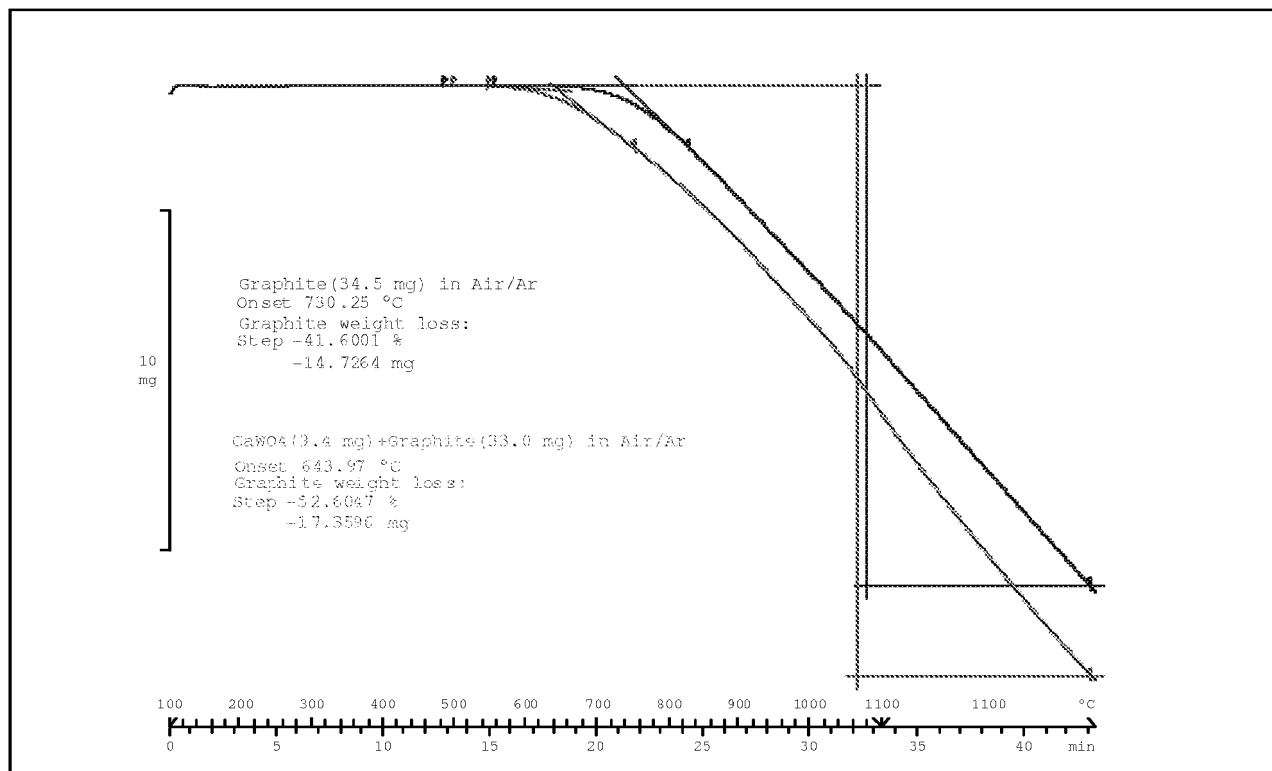


Fig. 10

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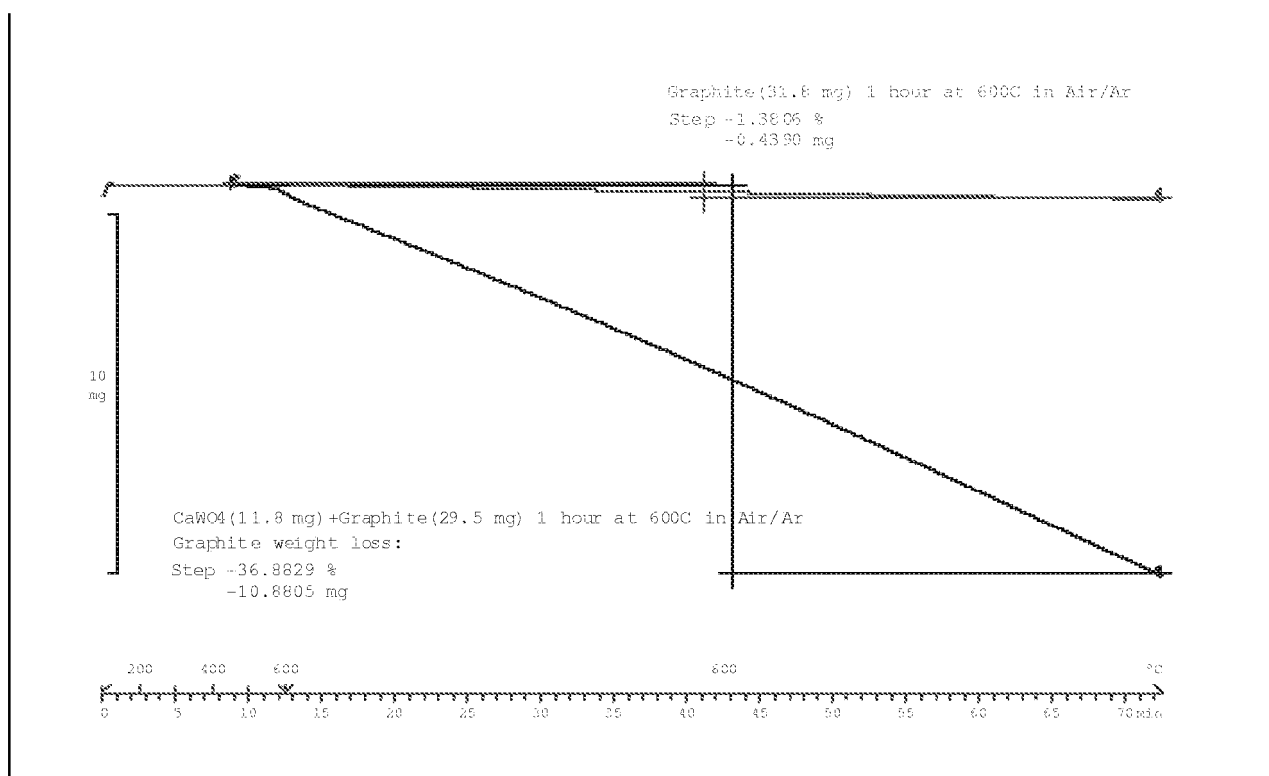


Fig. 11

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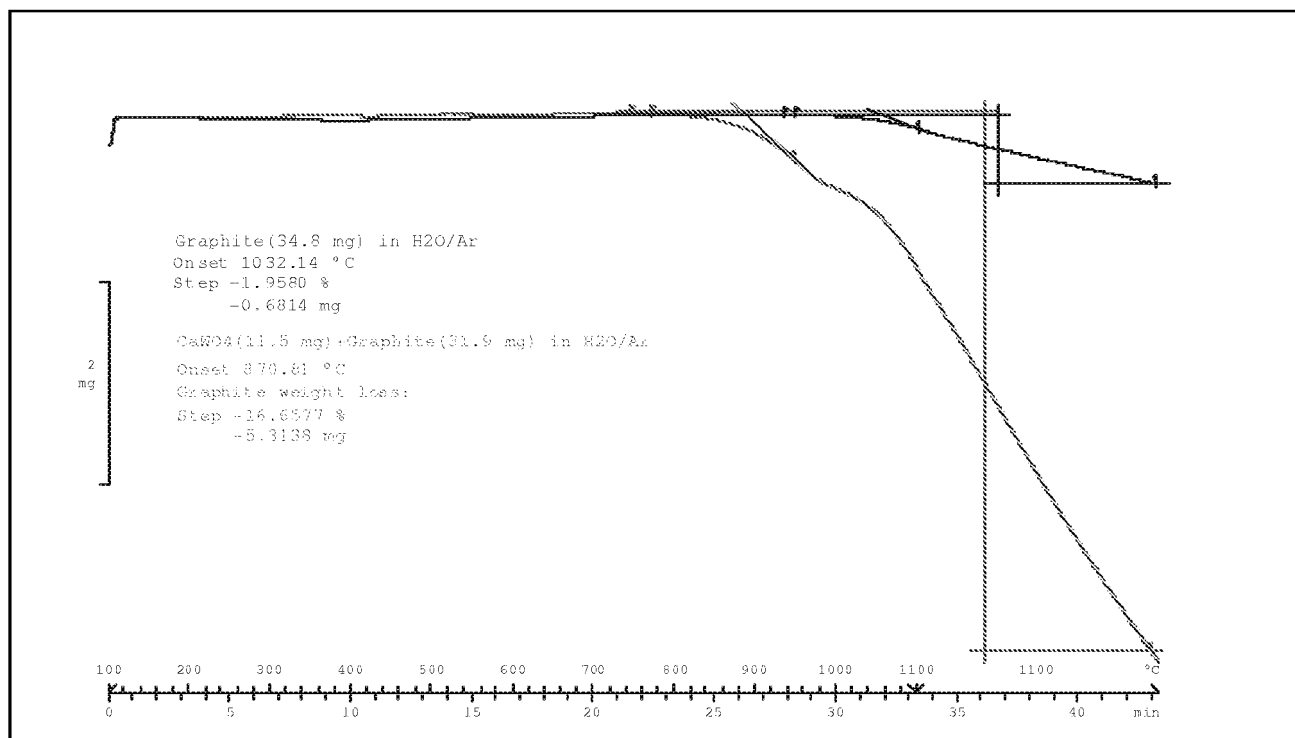


Fig. 12

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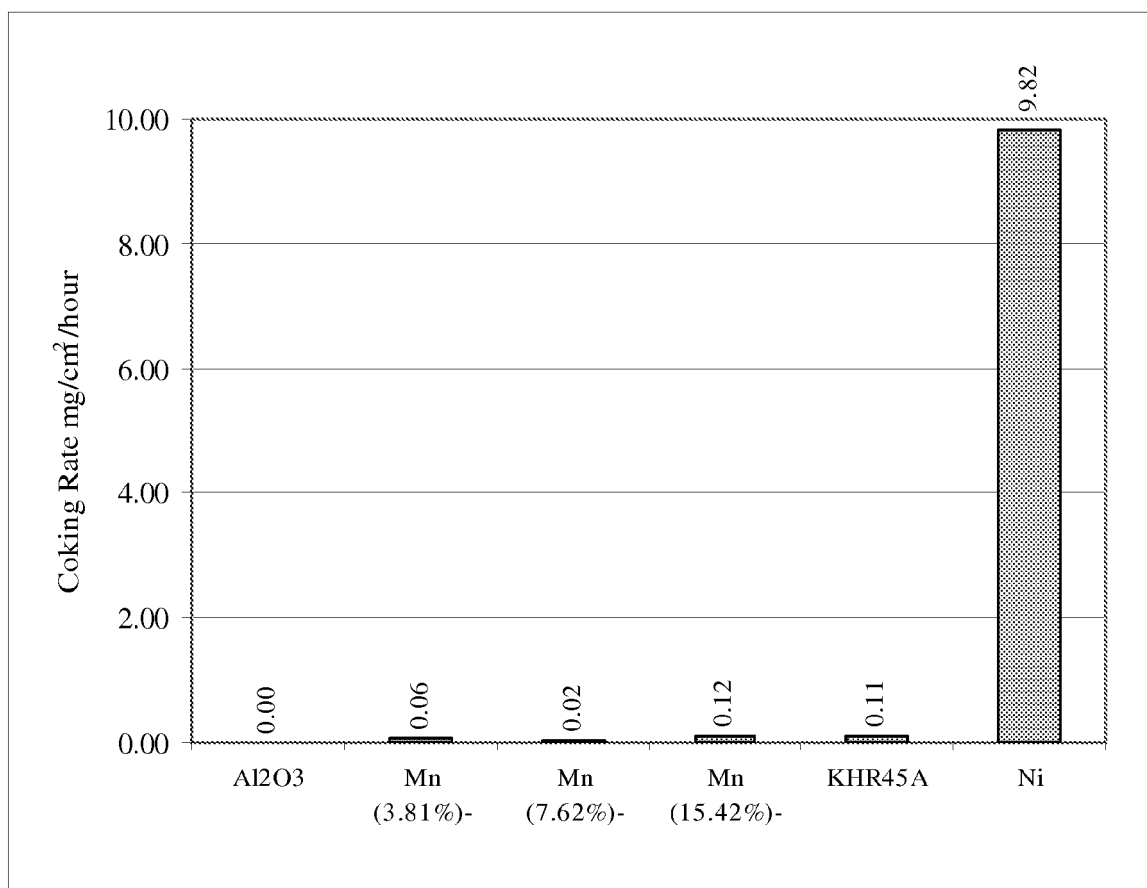


Fig. 13

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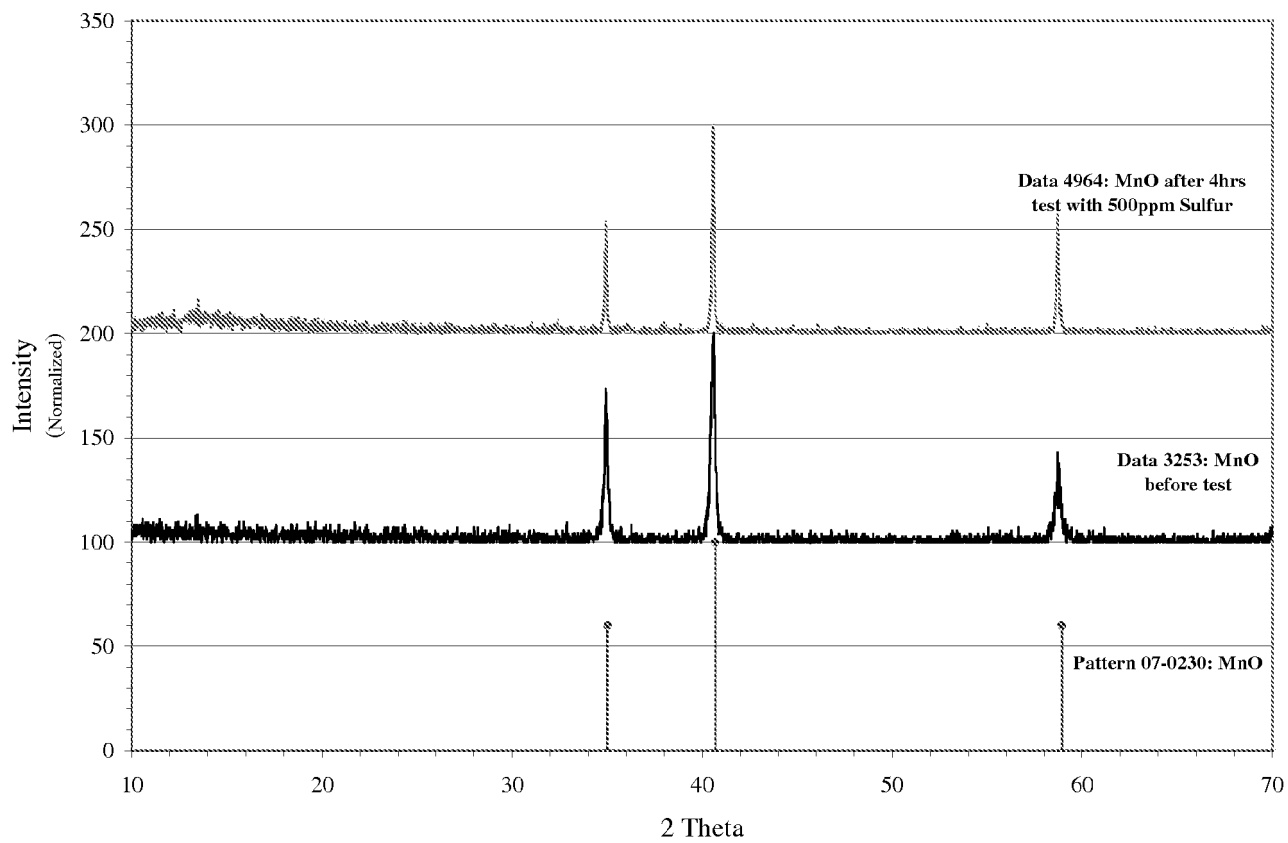


Fig. 14(a)

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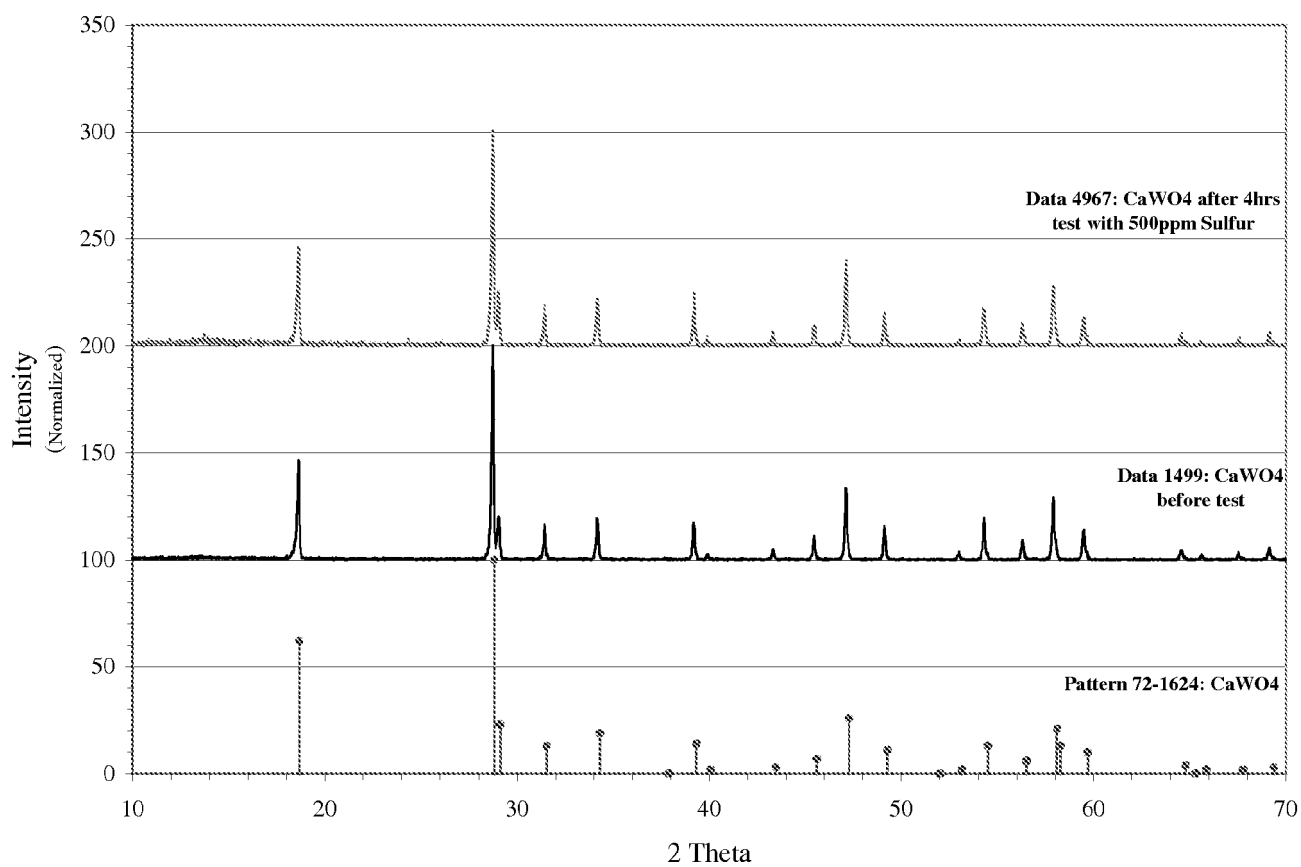


Fig. 14(b)

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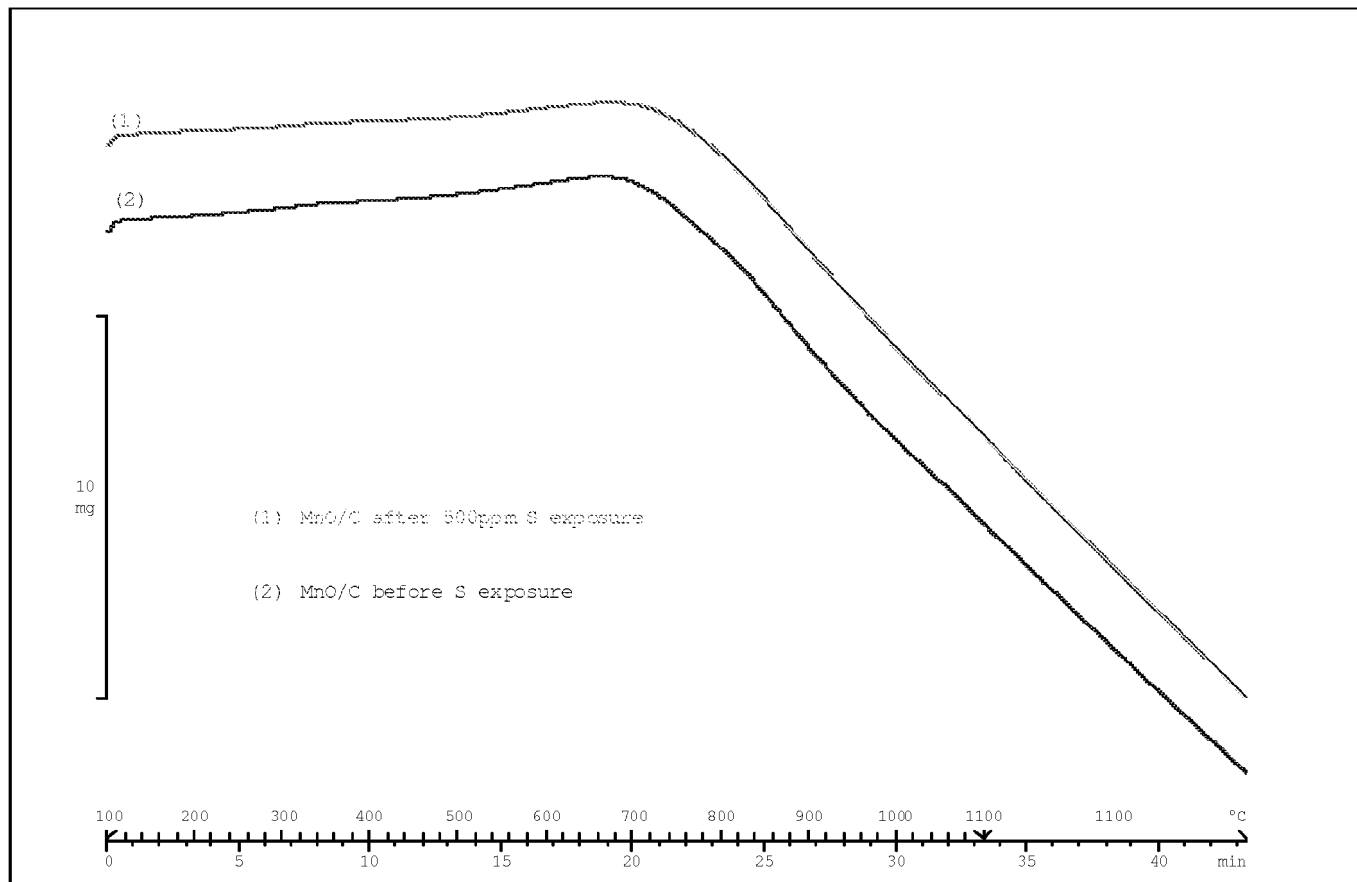


Fig. 14(c)

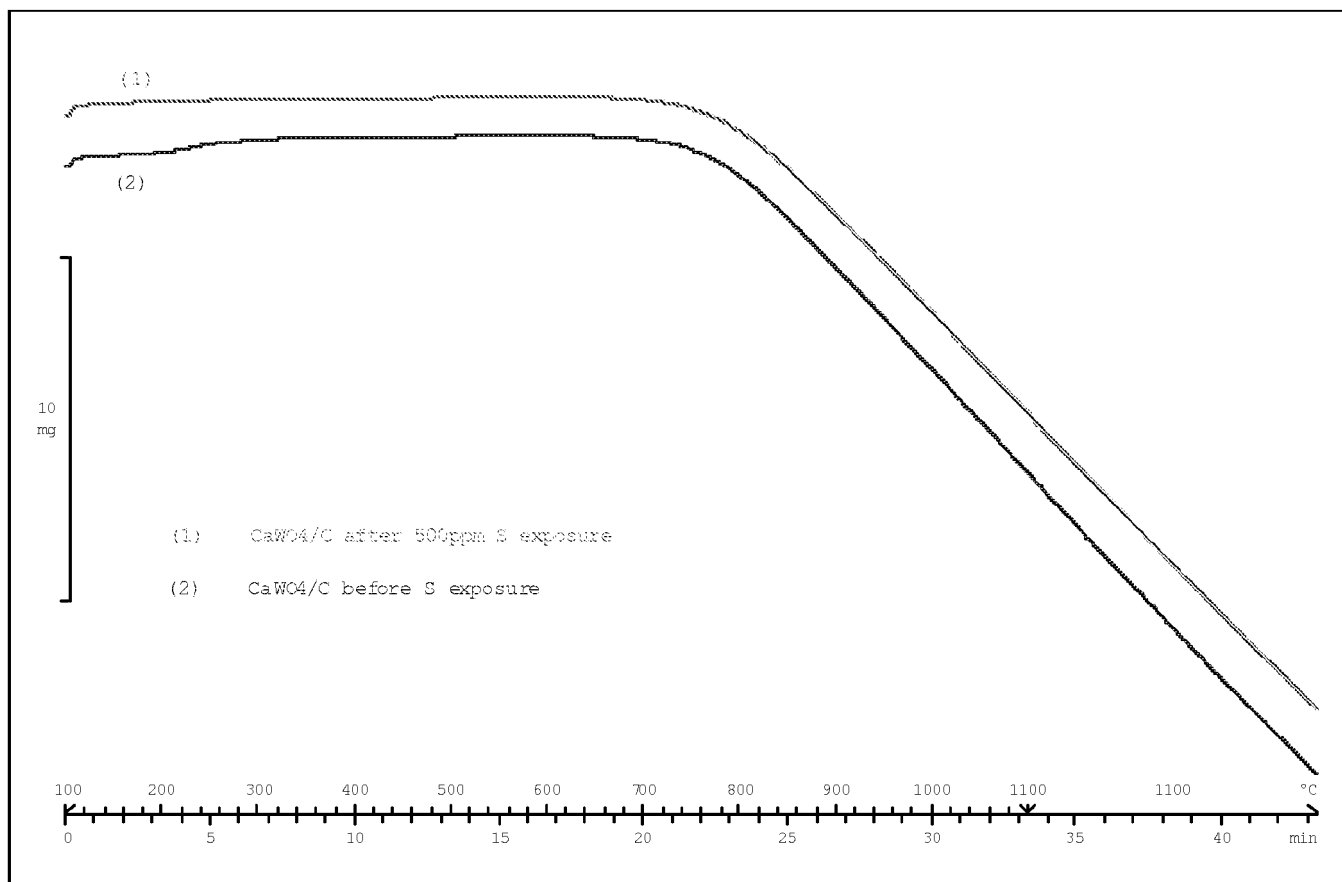


Fig. 14(d)

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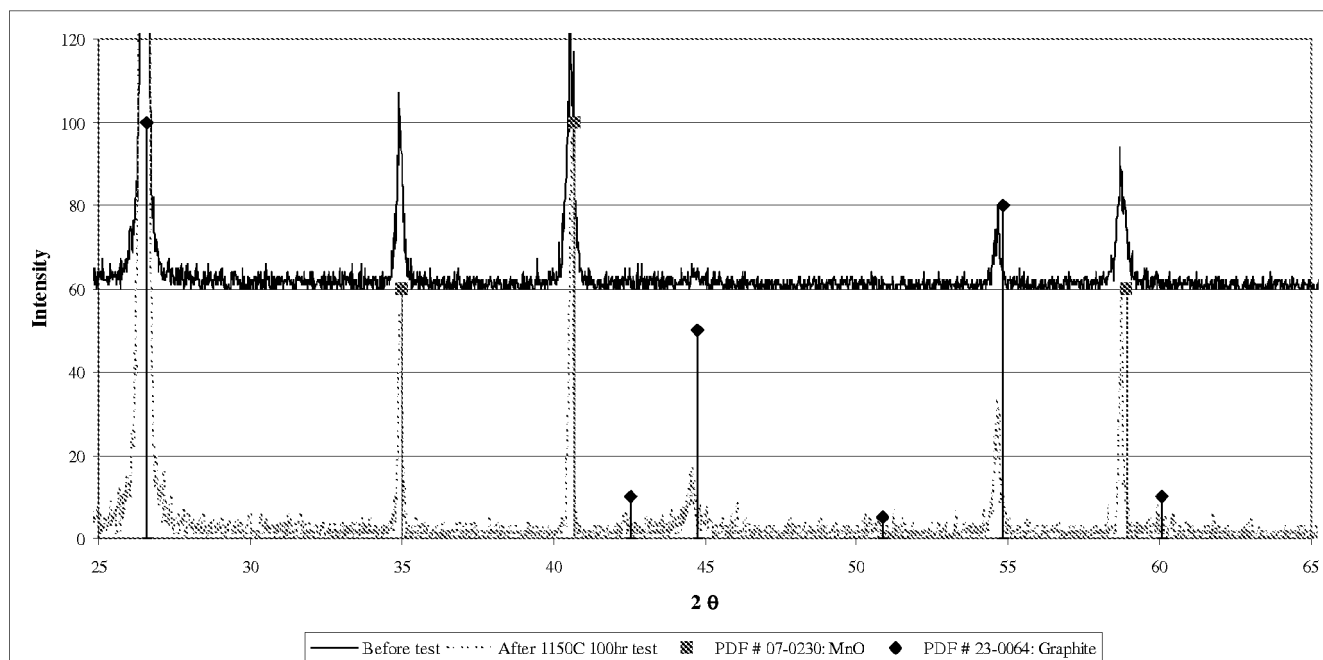


Fig. 15(a)

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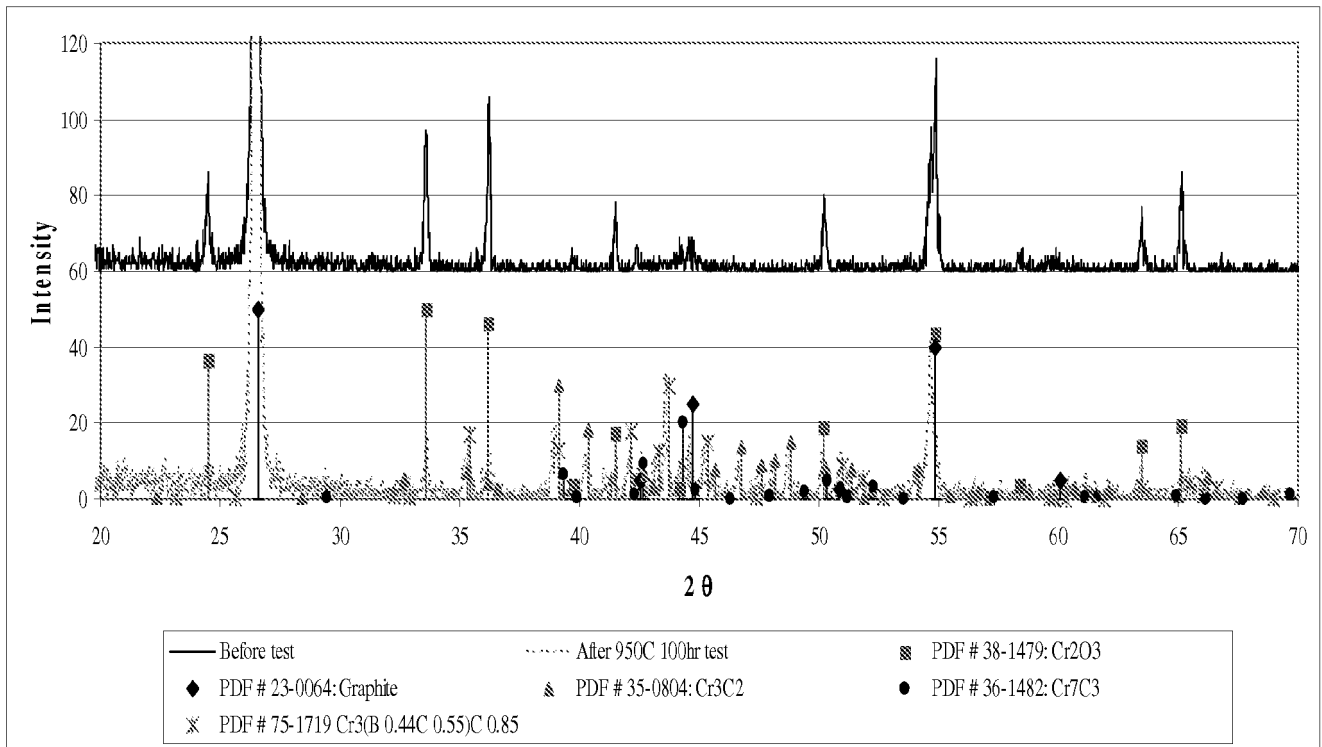


Fig. 15(b)

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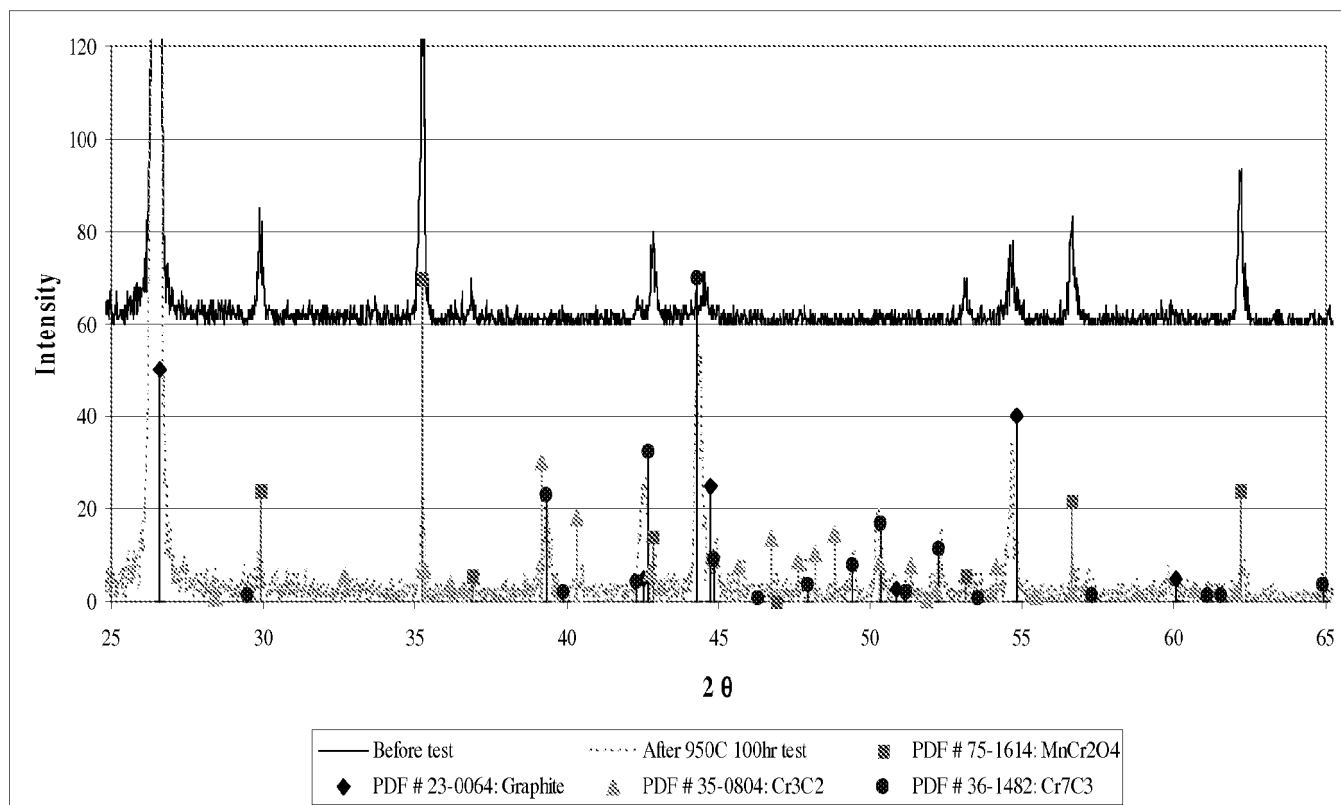


Fig. 15(c)

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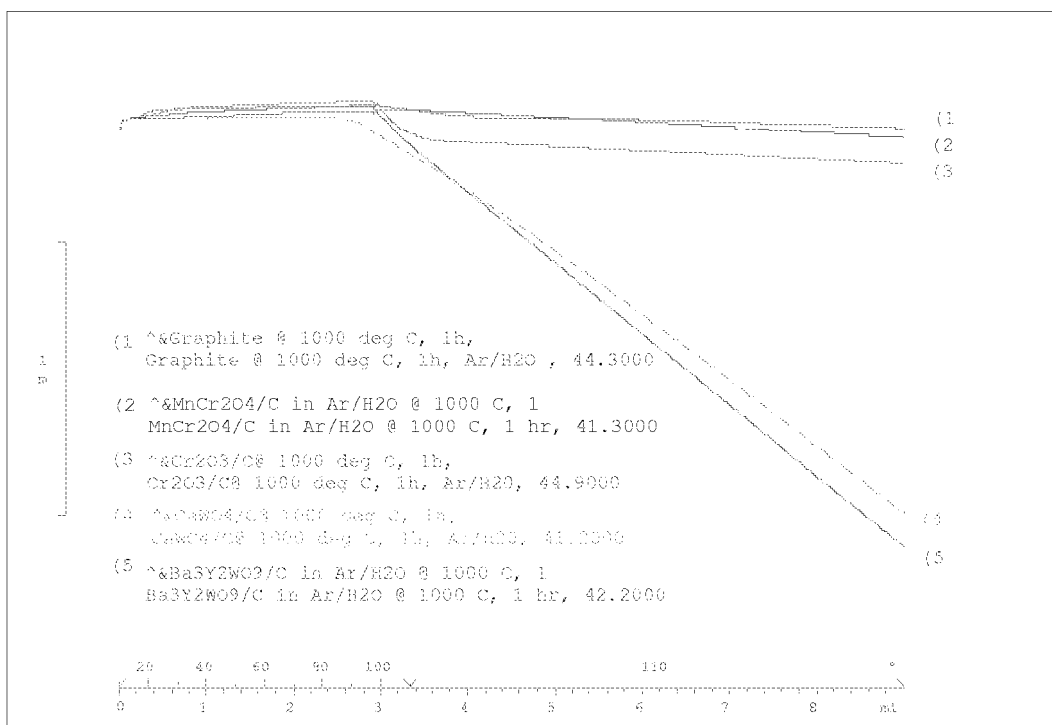


Fig. 16

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Reaction Temperature: 825°C Residence time: ~ 1.8 sec Steam:Ethane= 1:3	25Cr-35Ni-Fe Alloy	Modified 35Cr-45Ni-Fe Alloy
	Component wt%	Component wt%
	Average	Average
H ₂	5.79%	5.93%
CO ₂	0.00%	0.00%
CO	1.44%	1.43%
Methane	8.47%	8.81%
Ethane	15.78%	15.19%
Ethylene	58.61%	58.53%
Propane	0.06%	0.05%
Propylene	1.01%	1.00%
Acetylene	0.89%	0.90%
iso-Butane	0.02%	0.02%
n-Butane	0.06%	0.05%
Other C4 (GP)	0.23%	0.22%
C5 (GP)	0.19%	0.14%
1, 3-Butadiene (NC)	2.28%	2.30%
n-Hexane	0.00%	0.04%
Other C6 (GP)	1.02%	1.01%
Benzene	3.26%	3.48%
Toluene	0.33%	0.34%
C7&C7+ (GP)	0.43%	0.45%
Coke	0.13%	0.08%
Total	100.00%	100.00%
Ethane Conversion %	84.22%	84.81%
Ethylene Yield %	69.59%	69.02%

Fig. 17(a)

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Reaction Temperature: 825°C Residence time: ~ 1.8 sec Steam:Ethane= 1:3	Mn-based catalyst surfaces	Combined Mn-based and W-based catalyst surface
	Component wt%	Component wt%
	Average	Average
H ₂	6.24%	8.66%
CO ₂	0.20%	0.50%
CO	1.39%	1.04%
Methane	8.35%	8.29%
Ethane	15.32%	18.16%
Ethylene	58.79%	56.86%
Propane	0.05%	0.05%
Propylene	0.95%	0.51%
Acetylene	0.94%	0.69%
iso-Butane	0.02%	0.01%
n-Butane	0.05%	0.07%
Other C4 (GP)	0.22%	0.21%
C5 (GP)	0.18%	0.14%
1, 3-Butadiene (NC)	2.26%	1.75%
n-Hexane	0.00%	0.00%
Other C6 (GP)	0.96%	0.40%
Benzene	3.24%	2.20%
Toluene	0.32%	0.19%
C7&C7+ (GP)	0.44%	0.24%
Coke	0.06%	0.04%
Total	100.00%	100.00%
Ethane Conversion %	84.68%	81.84%
Ethylene Yield %	69.43%	69.48%

Fig. 17(b)

Steam Cracking	Heavy Liquid Feedstock Blend	800H (Machined Finish)	25Cr-35Ni-Fe Alloy (Machined Finish)	KHR45A Alloy (Machined Finish)	Modified 35Cr-45Ni-Fe Alloy (Oxidized Surface)
Reaction Temperature: 800°C Residence time: ~ 1.8 sec Steam:Feedstock 1:2 (wt)	Component wt%	Component wt%	Component wt%	Component wt%	Component wt%
	Average	Average	Average	Average	Average
H ₂		1.31%	1.36%	1.26%	1.45%
CO ₂		0.13%	0.08%	0.06%	0.11%
CO		0.95%	0.12%	0.14%	0.49%
Methane		23.87%	24.11%	23.63%	24.26%
Ethane		4.22%	4.31%	4.13%	4.12%
Ethylene		39.66%	39.98%	39.11%	39.76%
Propane		0.27%	0.27%	0.26%	0.25%
Propylene		9.23%	9.24%	9.20%	8.83%
Acetylene		0.79%	0.83%	0.82%	0.82%
iso-Butane		0.20%	0.20%	0.20%	0.19%
n-Butane		0.02%	0.02%	0.03%	0.02%
Other C4 (GP)		2.02%	1.84%	2.17%	2.15%
2-Methylbutane	21.79%	0.39%	0.41%	0.39%	0.38%
n-Pentane	33.61%	0.47%	0.37%	0.57%	0.66%
1, 3-Butadiene (NC)		3.53%	3.52%	3.46%	3.39%
Other C5 (GP)		0.27%	0.31%	0.33%	0.35%
Cyclo-hexane	5.22%	0.05%	0.00%	0.00%	0.01%
3-Methylpentane	15.51%	0.05%	0.04%	0.07%	0.14%
n-Hexane	11.55%	1.08%	1.45%	1.15%	1.51%
Other C6 (GP)		0.62%	0.38%	0.65%	0.38%
2,3-Dimethylpentane	5.67%	0.08%	0.05%	0.05%	0.05%
n-Heptane	4.46%	0.04%	0.14%	0.12%	0.14%
Benzene		6.86%	7.07%	7.19%	7.07%
Toluene	2.11%	2.28%	2.34%	2.39%	2.16%
C7&C7+ (GP)		1.53%	1.51%	2.56%	1.19%
Coke		0.06%	0.06%	0.06%	0.12%
Total	100.00%	100.00%	100.00%	100.00%	100.00%

Fig. 18(a)

Steam Cracking	Heavy Liquid Feedstock Blend	Mn-based catalyst surfaces	Combined Mn-based and W-based catalyst surface
Reaction Temperature: 800°C Residence time: ~ 1.8 sec Steam:Feedstock 1:2 (wt)	Component wt%	Component wt%	Component wt%
	Average	Average	Average
H ₂		1.53%	1.53%
CO ₂		0.38%	0.33%
CO		2.32%	1.41%
Methane		24.54%	23.95%
Ethane		4.38%	4.11%
Ethylene		39.15%	39.54%
Propane		0.25%	0.25%
Propylene		8.34%	8.77%
Acetylene		0.79%	0.83%
iso-Butane		0.19%	0.20%
n-Butane		0.02%	0.02%
Other C4 (GP)		1.44%	1.52%
2-Methylbutane	21.79%	0.36%	0.40%
n-Pentane	33.61%	0.21%	0.22%
1, 3-Butadiene (NC)		3.18%	3.41%
Other C5 (GP)		0.21%	0.20%
Cyclo-hexane	5.22%	0.00%	0.00%
3-Methylpentane	15.51%	0.00%	0.00%
n-Hexane	11.55%	1.07%	1.17%
Other C6 (GP)		0.53%	0.52%
2,3-Dimethylpentane	5.67%	0.04%	0.04%
n-Heptane	4.46%	0.11%	0.16%
Benzene		6.98%	7.25%
Toluene	2.11%	2.26%	2.30%
C7&C7+ (GP)		1.67%	1.79%
Coke		0.08%	0.08%
Total	100.00%	100.00%	100.00%

Fig. 18(b)

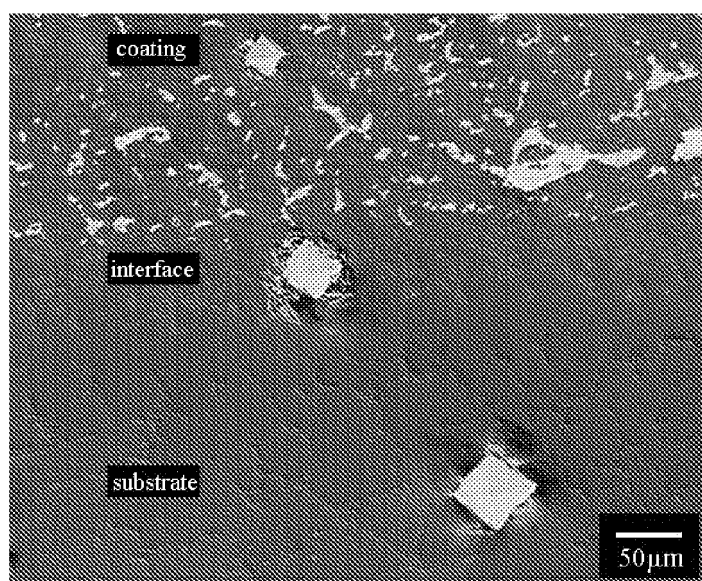


Fig. 19

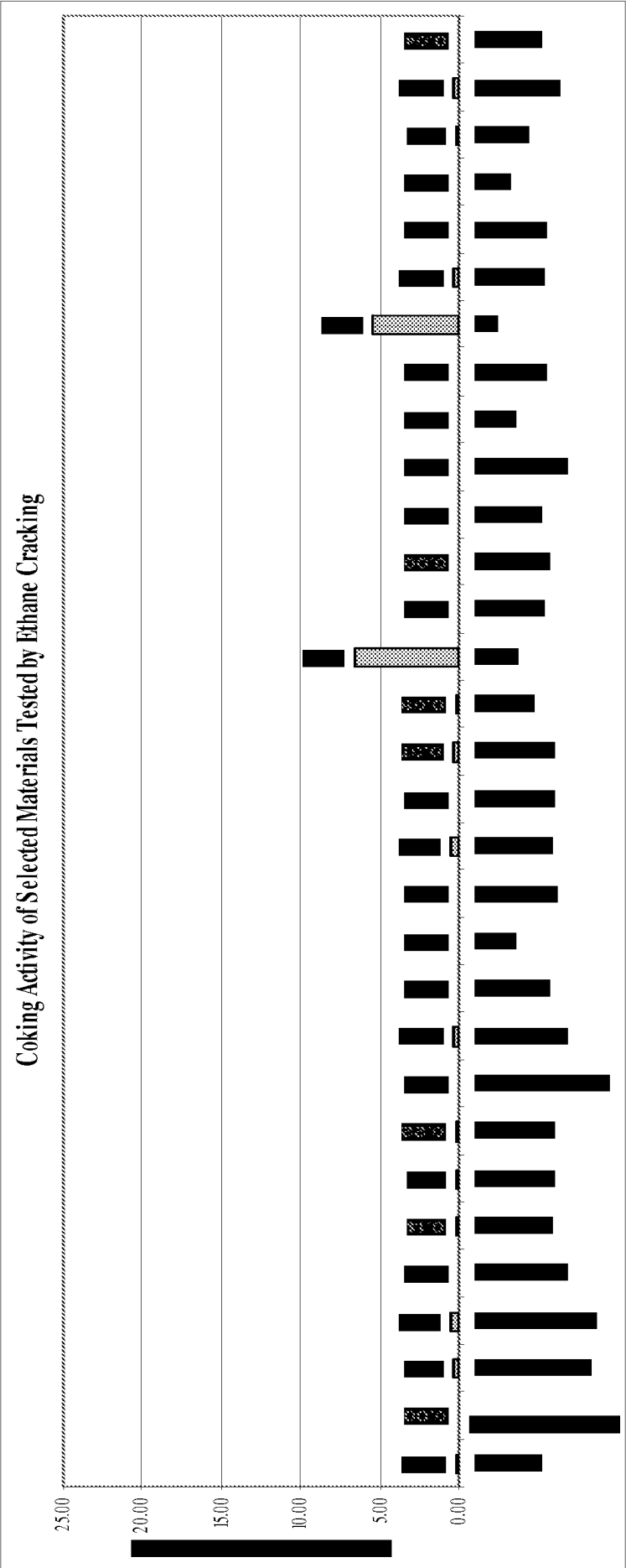


Fig. 20(a)

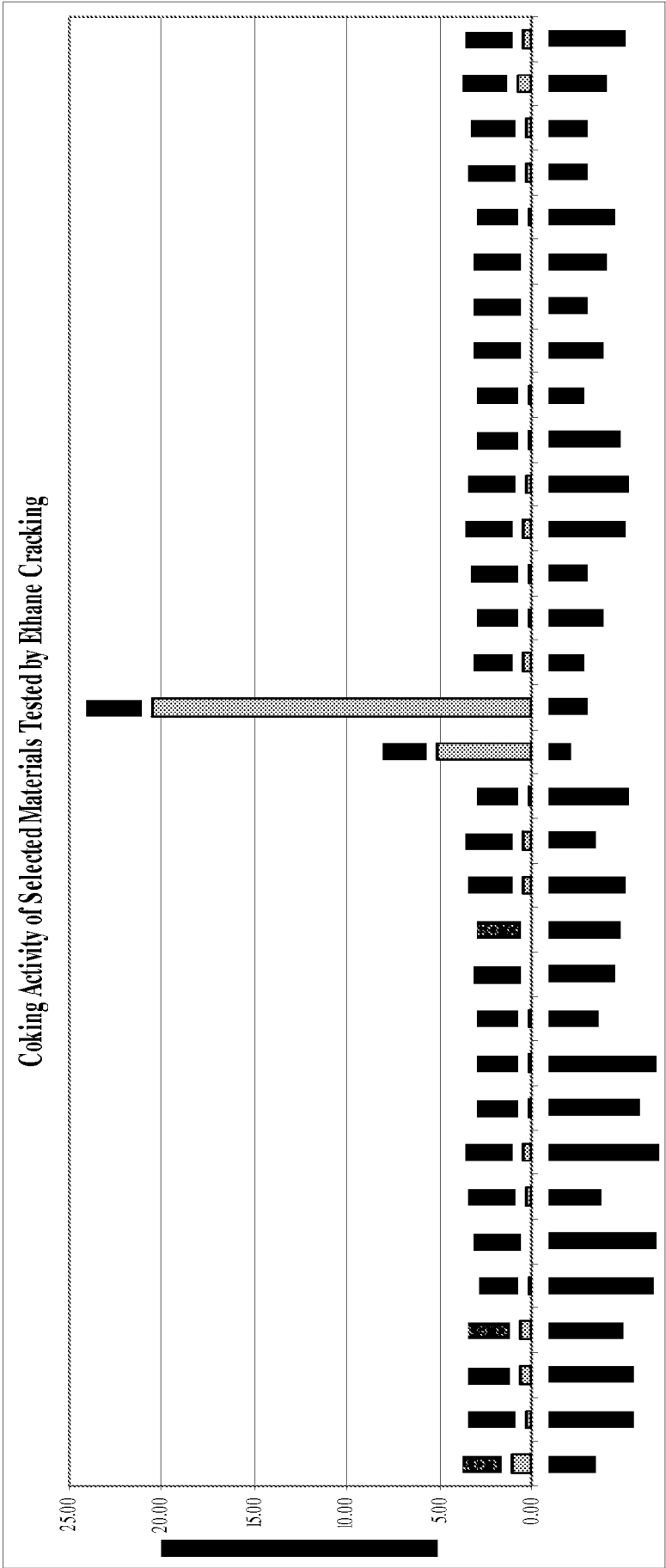


Fig. 20(b)